UNIVERSITY OF GONDAR

COLLEGE OF MEDICINE AND HEALTH SCIENCES

SCHOOL OF BIOMEDICAL AND LABORATORY SCIENCES

DEPARTMENT OF MEDICAL MICROBIOLOGY

PREVALENCE OF PULMONARY TUBERCULOSIS IN PRISON SETTINGS OF NORTH GONDAR ZONE, NORTHWEST ETHIOPIA

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A thesis submitted to the Department of Medical Microbiology, School of Biomedical and Laboratory Sciences, College of Medicine and Health Sciences, University of Gondar for partial fulfillment of the requirements for the degree of Master of Science in Medical Microbiology

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CERTIFICATE

This is to certify that the thesis entitled "**Prevalence of Pulmonary tuberculosis in prison settings of North Gondar zone, North west Ethiopia**" submitted by Teklay Gebrecherkos for the award of MSc., Degree in Medical Microbiology was carried out under our supervision and the thesis has not been previously submitted in part or full for any degree or diploma of this or any other University.

Advisors

Name _____ **Name** ----------

Signature _____ **Signature** ----------

June/2015

Gondar, Ethiopia

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LIST OF ABREVIATIONS

AFB - Acid Fast Bacilli

BMI - Body Mass Index

DOTS- Direct Observed Treatment; Short-course

HIV - Human Immuno-deficiency Virus

HSDP- Health Sector Development Program

ICRC - International Committee for Red Cross

LED-FM- Light Emitting Diode -Florescent Microscope

LJ - Löwenstein-Jensen

LPA –Line Probe assay

MDR- Multi-Drug Resistance

Mtb- Mycobacterium tuberculosis

NTCP - National Tuberculosis Control Program

PCR-Polymerase Chain Reaction

PICT -Providing Initiative Counseling and Testing

PTB -Pulmonary Tuberculosis

RIF - Rifampicin

SSA -Sub-Saharan Africa

TB - Tuberculosis

WHO- World Health Organization

XDR- Extensively drug resistant

ZN- Ziehl nelson

ABSTRACT

Background: Tuberculosis remains a major challenge to public health worldwide. According WHO, the prevalence of tuberculosis in prisons is very high, accounting for up to 25% of the TB burden in a given country, and is reported to be 10-to 100-folds higher than in the general population. Prisons are increasingly becoming ideal breeding grounds for the concentration and dissemination of TB including MDR-TB TB, from which infection is transmitted to the general population.

Objective: The aim of this study was to determine the prevalence of pulmonary tuberculosis and MDR-TB in prison settings of North Gondar zone (NGZ).

Materials and Methods: A cross-sectional study was conducted from February to April, 2015 among prisoners of NGZ. All prison inmates who had history of cough for ≥ 2 weeks were included in the study. Socio-demographic variables and potential risk factors were assessed using structured questionnaire. Pre and post HIV test counseling was provided after written consent obtained from PTB suspected inmates. Three sputum samples were collected and kept in ice box and transported to the University of Gondar. Sputum samples were examined through LED-FM and positive samples were further examined using Gene Xpert MTB/RIF assay for MDR-TB. Data was analyzed using SPSS version 20 and P-value < 0.05 was taken as significant.

Results: A total of 282 prison inmates suspected for PTB were enrolled in the study. The overall prevalence of smear-positive PTB was 5.3% (15/282). All smear positive PTB cases were found non-MDR-TB cases. The magnitude of TB/HIV co-infection among PTB cases was found 24%. Smear positive PTB infection was significantly associated with smoking (AOR =7.16, 95% CI= 1.76-29), malnourished (BMI <18.5kg/m2) (AOR =16.26, 95% CI= 4.5-67.9) and number of inmates per cell >100 (AOR= 10.32= 95% CI=3.29-8.51).

Conclusion and Recommendation: In this study, the prevalence of PTB among prisoners was found to be 2 times higher than in the general population. No MDR-TB case was detected. Factors such as TB/HIV co-infection, malnourished, overcrowding, smoking, previous history of contact with TB patient were associated with PTB infection. Special attention should be given to reduce spread of TB in prisons.

Keywords: Prison, MDR-TB, Pulmonary tuberculosis

1. INTRODUCTION

1.1 Background

Tuberculosis (TB) is an air borne infectious disease caused by the bacillus *Mycobacterium tuberculosis*. It typically affects the lungs (pulmonary TB) it can affect also other sites as well (extra pulmonary TB). The disease spreads in the air when people who are sick with pulmonary tuberculosis (PTB) expel bacteria, for example by talking, coughing, singing, sneezing and spiting. Overall, a relatively small proportion of individuals infected with *Mycobacterium tuberculosis* can develop TB disease; nevertheless, the probability of developing the disease is much higher among people infected with human imuno-deficiency virus (HIV) [1].

Once a person develops the disease, PTB, there will be several suggestive clinical presentations, especially two weeks' or more duration of cough, production of sputum and weight loss are important for the diagnosis of PTB. Others respiratory symptoms like chest pain, haemoptysis, breathlessness and/or constitutional symptoms like night sweats, fever, loss of appetite, fatigue, can also occur [2].

Multidrug resistant TB (MDR-TB), defined as resistance to at least isoniazid (INH) and rifampicin (RIF), are of the two most important first-line anti-TB drugs, has been spreading rapidly in recent years. Development of drug resistance TB is mainly associated with ineffective TB control programmes due to inadequate therapy, interrupted drug supply, poor patient compliance, and inappropriate treatment regimens [3].

'Prison' is a term used for any place of detention. It includes centers for pre-trial and convicted prisoners as well as centers for juvenile offenders and illegal immigrants. On any day, it is estimated that the world's prisons hold 8-10 million prisoners. However 4-6 times this number passes through prisons each year, because of the high turnover of the population. Prisons act as a reservoir for TB, pumping the disease into the civilian community through staff, visitors and inadequately treated former inmates [4].

Failure to effectively treat the patient will lead to further amplification of drug resistance leading to the development of MDR-TB [5]. Patients with MDR-TB on treatment should be nursed in isolation until sputum smear microscopy and cultures turn negative. Close monitoring of the

patient with Direct Observed Treatment, Short-course (DOTS) and follow-up is required after patient is discharged from the treatment facility. The best method of infection control remains the early diagnosis of infectious cases and the prompt initiation of effective treatment to prevent the emergence of drug-resistant TB [6].

1.2 Statement of the problem

Tuberculosis in the prison setting poses a major public health problem worldwide. Globally around 8.6 million new TB cases in 2012 were reported and 1.3 million die every year as a result of TB [7]. Prisons are settings in which TB transmission occurs and high rates of active TB have been reported worldwide, especially in countries of the former Soviet Union [8] and in Sub-Saharan Africa (SSA) [9], where TB in prisons threatens not only prison inmates, but also prison staffs who eventually interact directly with their families and community when they leave work [10]. This indicates that TB in prison is not only the concern of prisoners, but concerns the wider society at large and MDR-TB has become a major public health problem and presents new barriers to the control of TB in the world [11]. Nearly half a million cases of MDR-TB emerge every year, but only 3% of them get treatment globally and 110,000 die annually [12].TB and HIV co- infection and the exponential increase in MDR-TB are greatly responsible for the resurgence of tuberculosis [2].

According to the World Health Organization (WHO) 2013, the prevalence of TB in prisons is very high, accounting for up to 25% of the TB burden in a given country, and estimated to be 10- to 100-folds higher than the general population [13].

High levels of MDR-TB have been reported from some prisons with up to 24% of TB cases suffering from MDR-TB cases of the disease [14]. Prisons are increasingly becoming ideal breeding grounds for the concentration and dissemination of TB including MDR-TB, from which infection is transmitted to the general population [15]. In some studies there is high prevalence TB in prisons. For instance, study reports documented a 500 TB cases per 100.000 inmates in New York City jails, and 4,960 cases per100, 000 inhabitants in southern of Brazil prisons [16, 17].

In Africa, the prevalence of tuberculosis infection in prisons was previously reported higher, although the magnitude is different from country to country. Accordingly, a prevalence of 3, 574 per 100,000, 8937 TB cases per 100,000 and 6821 cases per 100,000 respectively were reported

in Malawi, in Zambia and Madagascar, respectively [18,19,20]. Demonstrating a 10 to 35 times higher prevalence of TB in prisons than in the general population.

Ethiopia ranks the 7th among the world's 22 high TB burden countries. According to WHO, 2013 report, the prevalence, incidence, and mortality rates in the country were 224 per100, 000, 247 per100, 000, and 18 per100, 000 populations, respectively. The same report showed that 1.6% of new TB patients and 12% of previously treated patients had MDR-TB [21]. Nevertheless, efforts had been made to treat TB cases in prisons and to control tuberculosis infection in some African countries. For example, Malawi has published guidelines on the implementation of specific interventions for TB in prisons [22]. The magnitude of tuberculosis infection among inmates of prisons in Ethiopia is not fully determined. However, there are very few study reports that estimated the prevalence of smear positive pulmonary tuberculosis infection in prisons. For example, a prevalence of 1913 per 100,000 inmates was reported by the year 2008 in Eastern Ethiopia [23] and another study in the Southern part of Ethiopia documented a 629/100,000 prevalence of smear positive pulmonary tuberculosis infection among prisoners by the year 2011 [24].

Previous report from a single prison in Gondar town prison demonstrated a prevalence of 1482 per 100,000 smear positive pulmonary tuberculosis infections among prison inmates [25]. Because this report was made from single prison in Gondar town prison, we believe that the report lacks representativeness as there are prisons in different weredas of North Gondar zone other than the Gondar prison present in Gondar town. Moreover, the previous study report also lacks the MDR-TB pattern of tuberculosis infection in the aforementioned prison. Thus, this study aimed to determine the prevalence of pulmonary TB and MDR-TB infection among the prisons of North Gondar zone.

2. LITERATURE REVIEW

Despite the fact that the global focus on TB control is on early diagnosis and treatment of people in high TB and TB/HIV-endemic countries, people in prisons are often neglected reservoirs for TB transmission threatening those in the outside community [2].

A study conducted in Thailand in the year 2007 shows that the prevalence of PTB was 1.2% or a point prevalence of 354.8/100 000 in prison inmates [26]. Across sectional study conducted in southern Brazilian prison showed a 3.8% tuberculosis prevalence (72/1,900 inhabitants). Of the TB cases, 17 patients (23.6%) had at least one prior TB episode and were considered retreatment cases. Thus, the incidence of new cases was 2.9% (55/1,900 inhabitants). The study also reported that 8 prisoners (11%) had a previous contact with TB outside the institution and also after imprisonment [17].

A study conducted in Dhaka central jail, Bangladesh reported that, among 1,781 TB suspects 245 (13.8%) was positive for PTB. Moreover, resistance to Isoniazid (INH), Rifampicin (RIF), was 11.4%, and 0.8%, respectively [27]. There are also reports that documented MDR-TB infection among prisoners in different parts of the world. For example, a cross sectional survey conducted in Russia by the year 2001–2002 showed prevalence of INH and RIF resistance among new prison TB cases was 38.0% and 25.2% , respectively [28]. In Uzbekistan the prevalence of MDR-TB infection was reported 23.2% among new TB cases and 62% among retreatment prisoners [29].

There are also reports which show high prevalence of PTB in Africa, in Cameron; Noeske et al reported a 3.5% point prevalence of pulmonary tuberculosis infection among prisoners. They also documented a 25% sero-prevalence of HIV infection among prisoners co-infected with tuberculosis but the prevalence of HIV was found by far lower (10.4%) among inmates that had no clinical signs for pulmonary tuberculosis infection [30].

A cross sectional study carried out at Mbarara central prison, Uganda between June 2012 to August 2012 showed a total of 648 in mates were screened and 248 inmates enrolled in the study, of which 2%(5/248) of them were positive for PTB [31].Another study conducted in Botswana jailed prisons shows that, from those of 1,027 prisoners and 263 guards at 4 prison settings during April-May 2002.The point prevalence of TB disease among prisoners was 3,797/100,000 and among guards it was 2,662/100,000.Of those 2 prisoners had resistance to

INH; 1 guard was resistant to INH, ETB and ST [32]. A study conducted from 2000-2001 in Zambian prisons found a 23.8% (n=40) resistance to at least one anti-tuberculosis drugs; where 9.5% (n=16) of them were MDR-TB or point prevalence of 262 per 100,000 populations, this rate was found to be on the upper limit of resistance rates reported among African countries [19]. But a study conducted in this setting in 2011shows, of the 160 individuals found be positive for tuberculosis, 1 (0.6%) had MDR-TB and 4 (2.5%) had tuberculosis that was resistant to INH only which decreases slightly this may be due published guidelines on the implementation of specific interventions for MDR-TB in prisons [33].

Prison tuberculosis infection was also previously reported in different parts of Ethiopia. Recently Abebe et al, (2008) conducted a survey in three major prisons in the Eastern parts of Ethiopia and found that among 371 pulmonary tuberculosis suspected prison inmates, 33 (8.9%) were confirmed as PTB positive . The study also reported that the point prevalence of PTB among prisoners in the area was 1913 per100 000, about seven times higher than that of the general population [23]. Another study conducted by Zerdo et al, (2012) in the Southern parts of Ethiopia aimed to determine the prevalence of pulmonary tuberculosis infection among prison inmates who had cough for at least two weeks found to be a prevalence of 19.4% (24/124) [24].

The recent report of Moges et al, (2011) in Gondar town prison showed a prevalence 10.4% smear positive PTB infection among tuberculosis suspected prisoners. The prevalence of HIV infection among the inmates was 7.6% and the prevalence of HIV infection among TB infected inmates was 34.6% (9/26) [25].

2.1 Risk factors for prison tuberculosis infection

Generally, persons at high risk for developing TB disease fall into two categories: persons who have been recently infected with TB bacteria and persons with medical conditions that weaken the immune system. Acquisition of tuberculosis bacteria could be due to close contacts of a person with infectious TB disease and groups of people with higher risk for TB transmission includes prisoners and persons with HIV infection [34].

Prisoners constitute a high risk group for acquisition of *Mycobacterium tuberculosis* infection and development of MDR-TB compared with the general population due to the overcrowding, high number of inmates per cell, poor ventilation, generally low socioeconomic status, poor nutrition, and poor health condition of prison inmates which can predispose imprisoned people to a high risk of TB incidence [35]. Prison inmates are often highly mobile, circulating within the prison from cell to cell and from prison to prison for another incarceration, and they may be released after some time. The incarcerated time, age, number of prisoners per cell, previous history of intravenous drug use, history of alcohol consumption, cigarette smoking and HIV infection are among the possible risk factors that may contribute for tuberculosis transmission in prisons [36].

Studies also have shown that malnutrition and/or a BMI<18·5 kg/m2 were associated with increased risk of developing TB in prisons. For instance, a study in Zambia found that nutritional status and food intake was universally poor in all surveyed prisons [33]. Similarly, studies in the Ethiopia, Russia, Cameroon, Tanzania and Ivory Coast reported a BMI < 18·5 kg/m2 as a significant predictor of TB [25, 27, 30, 37 and 38].

3. SIGNIFICANCE OF THE STUDY

Understanding the epidemiology of tuberculosis in prisons is necessary for governmental and other agencies to contribute in the implementation of effective tuberculosis control programs in prisons. The high prevalence of tuberculosis infection in the general society of the country in general and Gondar in particular could have contributed to the burden of TB in prisons in North Gondar administrative zone. In Ethiopia, there are limited studies regarding the prevalence of TB in prisons. However, previous report from Gondar showed a significantly higher prevalence of tuberculosis in a single prison. Nevertheless, the study report had not showed the drug susceptibility pattern of *Mycobacterium tuberculosis* isolates from that prison. We believe that understanding the magnitude of MDR-TB could contribute for effective treatment, prevention and control of tuberculosis infection in prisons in particular and the general community in general. Moreover, MDR-TB emphasizes the urgent need for the effective control of TB in prisons because it represents a health problem both in the penitentiary system and the community into which inmates are released. Thus, this study assessed the prevalence of PTB and MDR-TB with associated risk factors in prisons of north Gondar. Results of this study will contribute in designing strategies for prevention and control of TB prevalence and MDR-TB; strengthening the information available so far and encourage policy makers to design effective strategies to combat TB prevalence and MDR-TB in the study area and will serve as base line data to conduct further studies.

4. OBJECTIVES

4.1 General objective

The overall aim of this study was to determine the prevalence and multi drug resistance patterns of pulmonary tuberculosis in prison settings of North Gondar zone, North West Ethiopia.

4.2 Specific objectives

- To determine the magnitude of pulmonary tuberculosis in four prisons of North Gondar administrative zone
- To assess the burden of MDR-TB infection in these prisons
- To identify the factors that may contribute for the accusation of tuberculosis in these prisons.

5. MATERIALS AND METHODS

5.1 Study Design

A cross-sectional study was conducted among four prisons found in North Gondar administrative zone to estimate the prevalence and multi drug resistance of pulmonary tuberculosis.

5.2 Study area and period

The study was conducted from February - April, 2015 at three prisons (Debark, Dabat, Chilga and Gondar town) of North Gondar zone, Northwest Ethiopia. North Gondar zone has 21 weredas with 539 kebeles, 2 administration towns with 37 kebeles, according to the 2007 Ethiopian census report, North Gondar zone has a total population of 2,929,628, of whom 1,486,040 are men and 1,443,588 women .In this zone, there is one zonal and 21 weredas police stations and there are three large prisons that could hold about 1500-3500 prisoners. They receive mainly sentenced and some pre-trial prisoners from several surrounding weredas.

5.3 Population

5.3.1 Source population

The source of the sample was all the four prison inmates present in North Gondar zones.

5.3.2 Study population

All prison inmates who had cough for more than or equal to two weeks during the study period.

5.4 Inclusion criteria

Prisoners who are willing to participate and had two and above weeks duration of cough were included in the study.

5.5 Exclusion criteria

Prisoners who had two and above weeks duration of cough but were unable to produce sputum and inmates who are on anti-TB treatment and/or provided incomplete information were also excluded from the study.

5.6 Definitions of terms

A positive AFB smear: when at least two out of three smear results are positive or one positive result in case of HIV positive individuals is taken as smear

A negative AFB smear: When the result of the three sputum smears are negative for AFB

Multidrug resistant TB (MDR-TB) - Resistance to at least isoniazid and rifampcin

5.7 Variables

5.7.1 Dependent Variable

Prevalence of PTB and MDR TB

5.7.2 Independent Variables

- ✓ Age, sex,
- ✓ Educational status
- ✓ Marital status
- ✓ Length of staying in prison
- ✓ Frequency of imprisonment
- ✓ Prisoners per cell
- ✓ Pervious of Rt with TB
- ✓ HIV status
- ✓ Duration of cough
- -Smoking cigarette
- -Residence before incarceration
- -Time occurrence of cough
- - History of previous contact with active TB
- -Nutritional status
- -Sharing food and other materials
- -Window opening practice
- -Occupation before incarceration

5.8 Sample size and Sampling technique

5.8.1 Sample size

The minimum sample size was calculated by using single population proportion formula. Previous study done in North Gondar zone prison with prevalence of **10.4%** was taken for sample size determination [25]. Total sample size was calculated as follows: $ni= (Za/2)^2p (1-p)]/d^2$

Where ni= Initial sample size Z=95% confidence interval

d= Margin of error b/n the sample and the population (d=4%)

P= 10.4%

$$ni= \frac{(1.96)^2x0.104(1-0.104)}{(0.04)^2} = 223$$

By reviewing the record the average prison inmates in the three prisons of north Gondar are 3900,since this source population is less than ten thousand(N<10,000) sample size correction was used as follows:

$nf = \frac{in}{1+ni/N}$ where ; nf= the final sample size; N=source population , $nf= \frac{223}{1+223/3900}$

Considering a 10% non response rate the final sample size will be 212.8+22.3**=235**

But during study all inmates who fulfill the inclusion criteria were enrolled, hence they were **282**

5.8.2 Sampling technique

At the time of the study about 3900 inmates were held in the four prisons of the north Gondar zone. A mass screening strategy was used to identify PTB suspects. This strategy provides an equal chance of selecting eligible individuals, and reduces a chance of losing PTB suspects. First all prisoners were collectively questioned for the presence of cough then those prisoners with cough were individually interviewed about the duration of cough. Prisoners who had cough history of two weeks and above were included in the study. In this case, a total of 282 prisoners were actively selected to participate in the study. Once the inmate recruited eligible for the study,

socio-demographic characteristics, other study variables and sputum samples were collected following standard operational procedures. Moreover, all recruited participants were screened for HIV infection after getting consent from each inmate. Concerning HIV testing, nurses Providing Initiative counseling and Testing (PICT) in the prison clinics were involved. Prisoners with positive sputum smears were placed on anti-tuberculosis treatment as recommended by National Tuberculosis and Leprosy Control Program (NTLCP) guidelines [39], while smear-negative patients were given a 10-day course of broad spectrum antibiotic treatment.

5.9 Data collection and Laboratory methods

5.9.1 Socio-demographic data

Information on socio-demographic characteristics, imprisonment, number of prisoners per cell, history of previous treatment with TB, previous exposure to TB, window opening practice, cigarette smoking, and others was collected using a structured and pretested questionnaire.

5.9.2 Sample collection and Processing

Three spot- morning-spot sputum samples were collected from patients having cough of two and above weeks duration using coded and clean plastic containers by the investigator.

Sputum microscopy using a light emitting diode (LED) fluorescence microscopy

Spot- morning-spot sputum samples were collected from patients having cough of two and above weeks duration. Sputum-smear microscopy using a light emitting diode (LED) fluorescence microscopy (FM) was done at the University of Gondar on the day of collection following the manufacturer's procedures (PARTECGmbH). A smear was prepared from each sputum sample, stained and examined microscopically. Sputum was smeared on a labeled and clean frosted slides and allows to dry following fixing with heat and flood the slide with 0.1% auraminO for 20's and decolorized the smear by covering the glass slides with 0.5% acid-alcohol solution then after some minutes counter stain the smear by covering the glass slides with 0.1% potassium permanganate solution by incubating for one minute, washing with water in each of the above steps. The results of the sputum microscopy were graded following the WHO guide lines [40].

The remaining portion of sputum samples was stored at 4 ^{0}C in refrigerator and smear positive samples were transported and done at Gondar University Hospital for Gene Xpert to assess the MDR -TB.

Gene Xpert MTB/RIF assay

All positive PTB results using the LED fluorescent microscopy were further examined using the Gene Xpert MTB/RIF (Cepheid Gene Xpert system) to detect for rifampicin (RIF) resistance following the standard procedure. In brief, sample reagent was added to sample with 2:1 (v/v) proportion and mixed by hand shaking and incubated at room temperature for 15 minutes. After the incubation step, using the sterile pipette transfer 2 ml of the treated sample to the cartridge and the run is initiated. Then after about 2 hours, results interpreted and displayed by the machine as MTBC detected/not-detected and ‘‘RIF resistance not detected or detected”.

Nutritional assessment

Body weight was determined to the nearest 0.1 kg using an electronic digital scale and height was measured to the nearest 0.1 cm. Body mass index (BMI), defined as the weight in kilogram of the individual divided by the square of the height in meter, was used to determine the nutritional status of the patients as under nutrition (BMI < 18.5 kg/m2) and normal (BMI = >18.5 kg/m2) [41].

5.9. Quality Control

Data quality was maintained using translated questionnaires from English to Amharic language. Pre-testing of the questionnaire was done before data collection for completeness and appropriateness. Moreover, quality of reagents was done using known positive and negative controls.

5.10. Data analysis and Interpretation

Data was checked for completeness, cleaned manually and entered and analyzed using SPSS version 20 statistical package. Means and standard deviations were calculated for continuous variables while crude and adjusted Odds ratios (OR) with 95 % CI was calculated to check statistical association between the dependent and independent variables using the binary logistic regression and multivariable logistic regression models.

All variables of the study were initially tested for association with smear positivity by using the binary logistic regression model. Those which showed statistical significant association with smear positivity by the binary logistic regression model were put into the multivariable analysis

model to check if the association existed after controlling against all the rest of the variables and P-value less than 0.05 was considered as statistically significant.

5.11 Result dissemination

The final thesis will be submitted to Department of Medical Microbiology, School of biomedical and Laboratory sciences, College of Medicine and health sciences and University of Gondar. It will then be presented and defended and will be disseminated to North Gondar prison bureau, Gondar city administration Health bureau center for disease prevention and control team, plan and strategies, and other responsible bodies. The result will be published in international peer reviewed journals. Besides, it will be presented in scientific meetings and conferences so as to lobby for reformulation of national TB control policy with the necessary attention given to prison settings

5.12 Ethical considerations

The study was conducted after ethical approval obtained from ethical review committee of the School of Biomedical and Laboratory Sciences. Permission to conduct the research was obtained from prison authorities through recommendation letter written from the Department of Medical Microbiology. An informed consent was obtained from the study participants before interviewing and collecting specimen. Positive patients for TB and/or HIV were treated by the prison clinics staff following the nation’s standard for clinical management.

6. RESULTS

6.1. Socio demographic characteristics

A total of 282 prison inmates suspected for PTB were enrolled in this study. Among these, 98.2% (277/282) were males, 68.4% (193/282) were married, 50% (141/282) were unable to read and write, and 78% (220/282) were urban residents before incarcerated. The mean age of the patients was 35 (SD •±11.9) with median age of 30 (range: 16 to 80 years) and 35.1% (99/282) were in the age group of 25–34 years (Table 1).

Table 1: Socio - demographic characters tics of PTB suspected inmates enrolled in the study in North Gondar zone prisons from Feb – Apr, 2015.

Variables	Number (%)
Sex	
Male	277 (98.2)
Female	5 (1.8)
Age group (in years)	
15-24	63 (22.3)
25-34	99 (35.1)
35-44	50 (17.7)
>45	70 (24.8)
Residence before incarceration	
Rural	62 (22.0)
Urban	220 (78.0)
Educational Status	
No read and write	141 (50.0)
Elementary	107 (37.9)
High school and above	34 (12.1)
Occupation Before imprisonment	
Civil servant	13 (4.6)
Farmer	222 (78.7)
Merchant	13 (4.6)
Student	341(2.1)
Marital Status Before incarceration	
Single	77 (27.3)
Married	193 (68.4)
Divorced	12 (4.3)

6.2 Prevalence of pulmonary tuberculosis infection among prison inmates

The overall prevalence pulmonary tuberculosis infection among prison inmates in North Gondar prisons was 5.3 % (15/282) and the point prevalence was 384.6 per 100,000 prison population. The prevalence of smear positive prison inmates with MDR-TB was zero (all positive PTB cases were RIF sensitive).

The mean number of prisoners per cell was 233 (±126.5, 35–600). Moreover, 53.5% of the prisons had more than 100 inmates per cell which was significantly associated with increased risk for tuberculosis infection (AOR=10.32, 95% CI=3.29-8.51). In this study, sharing consumables such as food and other materials was significantly associated with tuberculosis infection. Prisoners whom were sharing food and other materials were 3.5% times (10/282) (AOR= 3.45, 95% CI=1.04-11.49) more at increased risk for tuberculosis infection than those inmates that never practiced common food and material usage. Moreover, it was also found that prisoners that do not open their cell window regularly had eleven 3.2% (9/282) (AOR= 11.28, 95% CI=2.25-56.7) times more risk than the corresponding inmates that practiced opening their cell window regularly.

Table 2: Socio-demographic variables of prison inmates in North Gondar Zone Prisons, using binary logistic and multivariable logistic regression analysis, N =282 from Feb - Apr, 2015.

Variables	**Pulmonary tuberculosis suspected inmates**						
	Positive n (%)	Negative n (%)	Total	COR (95%Cl)	P-Value	Adjusted OR (95%Cl)	P-value
Age							
15-24	3 (1.1)	60 (21.3)	63 (22.3)	1		1	1
25-34	6 (2.1)	93 (33)	99 (35.1)	1.29 (0.31-5.35)	0.72	2.33 (0.52-13.69)	0.662
34-44	2 (0.7)	48 (17)	50 (17.7)	0.83 (0.13-5.19)	0.84	1.45 (0.16-13.23)	0.655
>45	4 (1.4)	66 (23.4)	70 (24.8)	1.21 (0.26-5.63)	0.80	1.53 (0.24-12.30)	0.890
Sex							
Male	15 (5.3)	262	277 (98.2)	1		1	1

		(92.9)					
Female	0 (0)	5 (1.8)	5 (1.8)	0(00)	0.99	1.00	0.99
Residence							
Urban	2 (0.7)	60 (21.3)	62 (22)	1		1	1
Rural	13 (4.6)	207 (73.4)	220 (78)	1.88 (0.418.5)	0.413	2.81 (0.38-10.07)	0.317
Educational status							
No read and write	7 (2.5)	134 (47.5)	141(50)	1		1	1
Elementary	6 (2.1)	101 (35.8)	107(37.9)	1.14 (0.37-3.48)	0.820	1.36 (0.38-4.83)	0.217
High school and above	2 (0.7)	32 (11.3)	34 (12.1)	1.19 (0.24-6.03)	0.828	4.95 (0.39-62.91)	0.297
Occupation before incarcerated							
Civil servant	0 (0)	13 (4.6)	13 (4.6)	1		1	1
Farmer	14 (5)	208 (73.8)	222(78.7)	1.08 (00)	0.99	00	0.99
Student	1 (0.4)	33 (11.7)	34 (12.1)	4 (89)	0.99	00	
Marital status before incarcerated							
Single	5 (1.8)	72 (25.5)	77 (27.3)	1		1	1
Married	10 (3.5)	183 (64.9)	193 (68.4)	0.79 (0.26-2.36)	0.67	0.42 (0.09-1.99)	0.277
Divorced	0(0)	12 (4.3)	12 (4.3)	0	0.99	00	0.99
Length of stay in prisons (Month)							
< 2	2 (0.7)	25 (8.9)	27 (9.6)	1		1	1
2-6	3 (1.1)	55 (19.5)	58 (20.6)	0.68 (0.11-4.330	0.685	1.54 (0.12-10.30)	0.970

7-12	2 (0.7)	63 (22.3)	65 (23)	0.40 (0.05-2.97)	0.36	0.79 (0.06-5.65)	0.624
>12	8 (2.8)	124 (44)	132 (46.8)	0.81 (0.16-0.53)	0.029	1.02 (0.11-5.26)	0.759
Frequency of imprisonment							
Once	14 (5)	258 (91.5)	272(96.5)	1		1	1
Twice and above	1 (0.4)	9 (3.2)	10 (3.5)	2.05 (0.24-17.31)	0.511	10.52 (0.78-142.10)	0.062
Number of prisoners per cell							
<50	2 (0.7)	55 (19.5)	57 (20)	1		1	1
51-100	1 (0.4)	73 (25.9)	74 (26)	0.38 (0.03-4.26)	0.43	0.19 (0.01-2.90)	0.006
>100	12 (4.3)	139 (49.3)	151(53.5)	2.37 (0.52-10.95)	0.048	3.32 (3.29-8.51)	0.002*
Window opening practice							
Always	6 (2.1)	108 (38.3)	114 (40.4)	1		1	1
Some times	0 (0)	11 (3.9)	11 (3.9)	00	0.99	00	0.202
Never	9 (3.2)	148 (52.5)	157 (5 5.7)	1.09 (0.37-3.17)	0.028	11.28 (2.25-56.7)	0.003*
Sharing of food and materials							
No	5 (1.8)	38 (13.5)	43 (15.2)	1	1	1	
Yes	10 (3.5)	229 (81.2)	239 (84.8)	3.01 (0.65-0.97)	0.05	3.45 (1.04-11.49)	0.044****

* $P \leqslant 0.05$ (significance level). TB = pulmonary tuberculosis; OR = odds ratio; CI = Confidence interval; COR=Crude odds ratio

6.3. Clinical presentation of PTB among prison inmates

In this study, the majority 76.6% (216/282) of prison inmates reported that they had cough of 3 or more week's duration. In addition, 80.2% (226/ 282) of the respondents developed the cough after imprisonment. Among the eligible study subjects 9.6% (27/282) had history of previous treatment for TB and 1.1% (3/282) of them was currently positive for acid-fast bacilli. The prevalence of HIV infection among the tuberculosis suspected prisoners was 6% (17/282) and 24 % (4/17) of the HIV positive prisoners had pulmonary tuberculosis. HIV sero-prevalence was significantly associated with pulmonary tuberculosis infection among prisoners (AOR =7.26, 95% CI=1.10 – 33.30).

Those prisoners who reported cigarette smoking and had malnutrition (BMI <18.5kg/m2) were seven and sixteen times [AOR = 7.16 and 16.26, 95% CI=1.76-29.01 and 4.5-67.9) more likely to develop smear positive pulmonary tuberculosis infection than those prisoners who do not smoke and with normal nutrition status, respectively. Furthermore, those prisoners who had contact with active TB patient in their vicinity were about five times [AOR =5.03, 95% CI = 1.05-19.30) more likely to develop smear positive pulmonary tuberculosis than those who had no history of contact with known tuberculosis patients (Table 3).

Table 3: Clinical presentations for TB positivity among prison inmates in North Gondar zone prisons, using binary logistic and multivariable regression analysis, N = 282 from Feb –Jan,2015.

Variables	**Pulmonary tuberculosis suspected inmates**						
	Negative No (%)	Positive No (%)	Total	COR (95%Cl)	P-value	Adjusted OR (95%Cl)	P-value
Smoking							
No	232 (82.3)	9 (3.2)	241 (85.5)	1	1	1	1
Yes	35 (12.4)	6 (2.1)	41 (14.5)	4.42 (1.48-13.17)	0.008*****	7.16 (1.76-29)	0.006*****
Previous contact with TB							
No	182 (64.5)	4(1.4)	186 (66)	1		1	1
Yes	85 (30.1)	11 (3.9)	96 (34)	5.88 (1.48-13.17)	0.003*****	5.03 (1.05-19.6)	0.035*
Time occurrence of Cough							
Before imprisonment	50 (17.7)	6 (2.1)	56 (19.8)	1	1	1	1
After imprisonment	217 (77)	9 (3.2)	226 (80.1)	0.35 (0.12-1.02)	0.05	0.58 (0.15-2.20)	0.328
Duration of Cough (in weeks)							
2	51 (18.1)	2 (0.7)	53 (18.8)	1	1	1	1
3	29 (10.3)	1 (0.4)	30 (10.6)	0.88 (0,07-10.12)	0.918	0.55 (0.03-8.88)	0.67
4	63 (22.3)	2 (0.7)	65 (23)	0.81 (0.11-5.95)	0.83	0.57 (0.05-6.05)	0.64
≥8	124 (44)	10 (3.5)	134 (47.5)	2.05 (0.44-9.72)	0.363	1.45 (0.24-8.81)	0.68
Nutritional Status (BMI (kg/m2)							
≥18.5	238 (84.4)	5 (1.8)	243 (86.2)	1	1	1	

<18.5	29 (10.3)	10 (3.5)	39 (13.8)	16.41(5.25 -51.35)	0.000*****	16.26 (3.89-67.96)	0.000*****
History of previous Treatment							
No	243 (86.2)	12 (4.3)	255 (90.4)	1	1	1	1
Yes	24 (8.5)	3 (1.1)	27 (9.6)	2.53 (0.67-9.59)	0.172	0.24 (0.05-1.80)	0.170
HIV Status							
Negative	254 (90.1)	11 (3.9)	265 (94)	1	1	1	1
Positive	13 (4.6)	4 (1.4)	17 (6)	7.12 (1.99-25.37)	0.003*	7.26 (1.10-33.31)	0.024*

* $P \leqslant 0.05$ (significance level). TB = pulmonary tuberculosis; OR = odds ratio; CI = Confidence interval; COR=Crude odds ratio

7. DISCUSSION

Prisons are considered as reservoirs for facilitating *Mycobacterium tuberculosis* (*Mtb*) transmission within their walls, as well as to the community at large. Transmission occurs through prison staff, visitors, and released inmates after some time. The estimated prevalence of latent TB infection (LTBI) and active TB disease in prison systems are reported to be much higher than the average estimates in the general population, irrespective of the economic status and the population TB burden of the country [42]. In European prisons, the prevalence of TB was estimated to be up to 17 times higher than in the general population [12]. A similar epidemiological situations has been described in low and middle income countries including Bangladesh, Thailand, and Ethiopia, where TB prevalence has been reported to be almost four, eight, and seven times higher, respectively, among prisoners compared to the general population [28,26,23].

In Ethiopia, a number of epidemiological studies related to TB have been carried out in the last decades. However, there are only small numbers of studies that documented the prevalence of PTB and MDR-TB among prison inmates in the country in general and in north Gondar administrative zone prisons in particular. We believe that the current study can serve as a baseline data to fore cast the prevalence of PTB among north Gondar administrative region prisons.

The current study showed a prevalence of 5.3% (15/282) or point prevalence of 384.6 per 100,000 populations smear positive PTB infection which was 4.6 times higher than the global tuberculosis prevalence in the general population [43]. The prevalence of all forms of TB in the Amhara Regional State was reported 643 per 100,000 populations while the prevalence of smear positive TB infection was 168 per 100,000 populations in the same administrative region. Therefore, the prevalence of smear positive PTB infection among north Gondar prisoners was 2.3 times higher than the prevalence of PTB infection reported among the general population of the Amhara administrative region [44]. This indicates an increased risk of transmission of tuberculosis which could lead even to an outbreak in any of the north Gondar prisons and the general population at large unless immediate measures are taken. However, the prevalence of smear-positive PTB infection among the prisoners of north Gondar prisons was lower than the prevalence reported in Gamo Goffa zone, southern Ethiopia, which was 19.4%. Moreover, the prevalence of tuberculosis infection in prisons was reported 8-fold higher than the prevalence in

the general population in the southern Ethiopia [24] .The prevalence of smear-positive PTB infection among north Gondar prisoners was lower than the report from some Ethiopian prisons, 1913/100,000 in Eastern Ethiopia, and 629/100,000 in Southern Ethiopia [23, 24]. Furthermore, there was only one study conducted in a single prison in our setting and the prevalence of smear-positive PTB infection was reported 1482/100,000 populations which is also higher than the prevalence result of the present study [25]. In the present study the prevalence of smear-positive PTB was determined among the inmates of the four prisons namely Debark, Dabat, Chilga and Gondar towns that may have its own significance to the prevalence difference between the current study and the previous one which was conducted only among prisoners of the Gondar town. On the other hand, compared to the current result, lower prevalence of PTB was reported from prisons of some Asian, European and African countries, 355/100,000 in Thailand, 259/100,000 in Taiwan, ,308/100,000 in Uganda and jail of Lahore Malawi, 339/100,000 [9,26,31,45]. The relatively lower prevalence in these countries could be due to a good TB control strategy and low TB incidence in the general population.

The current study revealed that majority 4.6% (13/282) of the TB positive inmates developed cough after they joined the prisons. Longer duration of cough, transfer of prisoners from one prison to another before completion of treatment, diagnostic and treatment delay, all could contribute for inter-prison and prison-to-population transmission. Moreover, the delay in diagnosis and treatment for TB cases may result in an MDR-TB epidemic unless appropriate attention is given to the prison population.

In the present study, none of the smear-positive prisoners showed any type of drug resistance against rifampicin which was determined by the Gene Xpert technology. Drug resistance against the anti-TB drug rifampicin was previously used as a surrogate maker of drug resistance and MDR-TB against anti-TB drugs. Different reports showed a higher rate of MDR-TB infection among prisoners in different parts of the world and some African prisons [19, 24, 28, 29]. For example, the rates of resistance were significantly higher in prisoners, with rate ratios (RR) of 1.9 for MDR-TB [27].

Even though there wasn’t any significant association between the duration of cough and TB positivity in this study, it could still show an extended time before patients get diagnosed and treated rendering the smear positive prisoners to transmit the infection to many others. This

could be intensified by the nature of the cells shared by the inmates. The number of inmates per cell more than 100 was significantly associated (P=0.001) with PTB positivity. Indicating cells in the study area were poorly ventilated and overcrowded. Inmates who share their food and materials with their colic's were significantly associated with PTB positivity (P=0.044). This could enhance high TB transmission with in prison inmates and can further has a chance to transmit to the general community because they interact directly with their families or other relatives who come to visit them.

The result of this study showed that prisoners who reported cigarette smoking were seven times more likely to develop smear positive pulmonary tuberculosis infection than those prisoners who do not smoke. Several studies have linked smoking with tuberculosis [46, 47] used binomial regression to propose that heavy smoking was associated with pulmonary tuberculosis. The alveolar macrophage is probably the first cell to ingest a tubercle bacillus following infection. These cells suppress the local immune response in order to preserve lung architecture and both smoking and tuberculosis induces apoptosis of these cells [48, 49].

Malnutrition prisoners were found sixteen times more likely to develop tuberculosis compared with normal prisoners. The association between tuberculosis infection and malnutrition has been recognized for a long time. Malnutrition may predispose to TB, and in turn TB often causes malnutrition [50, 51] .In a rat model as a consequence of malnutrition, there were lower numbers of alveolar macrophages (AMs) in the broncho alveolar lavage fluid and toxic radical such as NO releases by AMs were impaired. Moreover, monocytes obtained from malnourished adult patients suffering from fibrocaseous TB showed inadequate stimulation even with recombinant gamma interferon. These results suggest macrophage dysfunction to produce NO2- in malnourished patients suffering from TB [52].

The study results show that having PTB was significantly associated with history of active TB patient contact (P=0.035). Thirty percent of inmates having history of previous contact with active TB patients showed clinical signs and symptoms for PTB and among these inmates 3.9% were positive for PTB. This shows that tuberculosis causing bacteria is circulating in the prisons that make the risk of acquiring TB in prisons very high.

In the current study, 6% (17/282) of the prisoners were found reactive for HIV antibody test and 1.4% (4/282) of them had PTB co-infection. The prevalence of HIV infection in the TB infected

inmates was calculated 24%. The prevalence of TB/HIVco- infection in the current study was higher than reports from Spanish and Tanzanian prisoners that showed 17.9% and 22% PTB/HIV co-infection, respectively [37,53]. While it was lower than the study conducted in North west Ethiopia and Malawian prisoners who had PTB/HIV co-infection in up to 34.6 and 73% of the cases, respectively [25,9]. A core challenge to TB control in prison systems is dealing with the dual epidemics of HIV and TB, as well as other co-infections such as with hepatitis B or C virus. Given the impact that HIV has on TB cases and vice versa, coordination between TB and HIV programmes is vital [54]. However, this may be limited due to poor surveillance of HIV among prisoners with TB, challenges in the diagnosis of TB among people living with HIV and lack of joint planning and mobilization for TB/HIV co-infection, and inadequate human resources capacity for managing TB/HIV [19, 54]. In addition, a coordinated system, supported by the ministries of health, welfare, and justice or interior, should implement a holistic approach to patients in correctional facilities.

8. CONCLUSION

The point prevalence of smear-positive pulmonary tuberculosis infection among north Gondar prisoners was 384.6 /100,000. The prevalence of smear positive pulmonary tuberculosis infection among North Gondar zone prisoners was found to be 2 times higher than the general population. High number of inmates per cell, smoking, malnutrition, sharing of food and materials, and previous history of contact with active TB cases were found significant risk factors for to acquire tuberculosis in prisons. The majority of the TB positive inmates developed cough after they joined the prisons which might indicate that they acquired TB within the prison. Six present of the prisoners were positive for HIV and the serum of half of the smear-positive TB cases were reactive for HIV antibody.

9. RECOMMENDATION

Failure to control tuberculosis in prisons has the potential to disseminate tuberculosis to the general population. Therefore, establishing active and regular tuberculosis screening program requires urgent implementation. Reducing the burden of prison inmates within a particular cell, restricting access to smoking and establishing ventilation system can possibly minimize the transmission of tuberculosis among prisoners. Screening prisoners for HIV infection prior imprisonment may clarify the risk of acquiring HIV within the prison particularly for prisoners incarcerated for long period of time. Furthermore, preventive activities, including wider health education (e.g. needle exchange or cleansing programmes, or safe sex), prevention of malnutrition among prisoners possibly contribute to reduce the burden of tuberculosis infection in prisons.

Further large scale research should be conducted on the prevalence of PTB and MDR-TB infection and potential risk factors in prisons using advanced diagnostic tools such as culture and Gene Xpert. In addition, evidence of the circulating strains, genotyping and transmission dynamics inside the prison setting is also warranted.

10. REFERENCES

1. Tiemersma EW, van der Werf MJ, Borgdorff MW, Williams BG, Nagelkerke NJ. Natural history of tuberculosis: duration and fatality of untreated pulmonary tuberculosis in HIV negative patients: A systematic review. *PloS one*. 2011; 6 (4).
2. Harries AD, Maher D, Graham S. TB/HIV: a clinical manual: World Health Organization; 2004.
3. Urassa W., Mugusi F., Villamor E. et al., "Primary antimicrobial resistance among *Mycobacterium tuberculosis* isolates from HIV seropositive and HIV seronegative patients in Dares Salaam Tanzania," *BMC Research Notes*. 2008; 1(58).
4. Telisinghe L, Fielding KL, Malden JL, Hanifa Y, Churchyard GJ, Grant AD, et al. High tuberculosis prevalence in a South African prison: the need for routine tuberculosis screening. *PloS one*. 2014; 9 (1).
5. Borchardt JK. Tuberculosis: Resurgence of a historic scourge. Drug news and prespective. 2002;15(8):535
6. Biadglegne F, Tessema B, Rodloff AC, Sack U: Magnitude of gene mutations conferring drug resistance in *mycobacterium tuberculosis* isolates from lymph node aspirates in ethiopia. *Int J Med Sci* 2013;10(11):1589–1594.
7. Otu A, Umoh V, Habib A, Ameh S, Lawson L, Ansa V. Drug Resistance among Pulmonary Tuberculosis Patients in Calabar, Nigeria. Pulmonary medicine. 2013; 2(7):29-35.
8. Jugheli L, Rigouts L, Shamputa I, Bram de Rijk W, Portaels F. High levels of resistance to second-line anti-tuberculosis drugs among prisoners with pulmonary tuberculosis in Georgia. *The International Journal of Tuberculosis and Lung Disease*. 2008; 12(5):561-6.
9. Banda H, Gausi F, Harries A, Salaniponi F. Prevalence of smear-positive pulmonary tuberculosis among prisoners in Malawi: a national survey [Short communication]. *The International Journal of Tuberculosis and Lung Disease*. 2009; 13(12): 1557-9.
10. Balabanova Y, Nikolayevskyy V, Ignatyeva O, Kontsevaya I, Rutterford CM, Shakhmistova A, et al. Survival of civilian and prisoner drug-sensitive, multi-and extensive drug-resistant tuberculosis cohorts prospectively followed in Russia. *PloS one*. 2011; 6(6):e20531.

11. O'Grady J, Hoelscher M, Atun R, Bates M, Mwaba P, Kapata N, et al. Tuberculosis in prisons in sub-Saharan Africa–the need for improved health services, surveillance and control. Tuberculosis. 2011; 91(2):173-8.
12. Aerts A, Hauer B, Wanlin M, Veen J. Tuberculosis and tuberculosis control in European prisons. *The International Journal of Tuberculosis and Lung Disease*. 2006; 10(11):1215-23.
13. Abubakar I, Zignol M, Falzon D, Raviglione M, Ditiu L, Masham S, et al. Drug-resistant tuberculosis: time for visionary political leadership. *The Lancet infectious diseases*. 2013; 13(6):529-39.
14. Skrahina A, Hurevich H, Zalutskaya A, Sahalchyk E, Astrauko A, Hoffner S, et al. Multidrug-resistant tuberculosis in Belarus: the size of the problem and associated risk factors. *Bulletin of the World Health Organization*. 2013; 91(1):36-45.
15. Toungoussova OS, Mariandyshev A, Bjune G, Sandven P, Caugant DA. Molecular epidemiology and drug resistance of Mycobacterium tuberculosis isolates in the Archangel prison in Russia: predominance of the W-Beijing clone family. *Clinical infectious diseases*. 2003;37(5): 665-72.
16. Valway SE, Richards SB, Kovacovich J, Greifinger RB, Crawford JT, Dooley SW. Outbreak of multi-drug-resistant tuberculosis in a New York State prison, 1991. *American journal of epidemiology*. 1994;140(2):113-22.
17. Kuhleis D, Ribeiro AW, Costa ERD, Cafrune PI, Schmid KB, Costa LLd, et al. Tuberculosis in a southern Brazilian prison. *Memórias do Instituto Oswaldo Cruz*. 2012; 107(7):909-15.
18. Nyangulu D, Harries A, Kang'Ombe C, Yadidi A, Chokani K, Cullinan T, et al. Tuberculosis in a prison population in Malawi. The Lancet. 1997;350(9087):1284-7.
19. Habeenzu C, Mitarai S, Lubasi D, Mudenda V, Kantenga T, Mwansa J, et al. Tuberculosis and multidrug resistance in Zambian prisons, 2000-2001. *The international journal of tuberculosis and lung disease.* 2007;11(11):1216-20.
20. Rasolofo-Razanamparany V, Ménard D, Ratsitorahina M, Aurégan G, Gicquel B, Chanteau S. Transmission of tuberculosis in the prison of Antananarivo (Madagascar). *Research in microbiology*. 2000;151(9:785-95.

21. World Health Organization, Global Tuberculosis control report: WHO, WHO, Geneva, 2011.
22. Harries A, Nyirenda T, Yadidi A, Gondwe M, Kwanjana J, Salaniponi F. Tuberculosis control in Malawian prisons: from research to policy and practice. *The International Journal of Tuberculosis and Lung Disease*. 2004; 8(5): 614-7.
23. Abebe D, Bjune G, Ameni G, Biffa D, Abebe F. Prevalence of pulmonary tuberculosis and associated risk factors in Eastern Ethiopian prisons. *The International Journal of Tuberculosis and Lung Disease*. 2011;15(5): 668-73.
24. Zerdo Z, Medhin G, Worku A, Ameni G. Prevalence of Pulmonary Tuberculosis and Associated Risk Factors in Prisons of Gamo Goffa Zone, South Ethiopia: A Cross-Sectional Study. *American Journal of Health Research*. 2014; 2(5):291-7.
25. Moges B, Amare B, Asfaw F, Tesfaye W, Tiruneh M, Belyhun Y, et al. Prevalence of smear positive pulmonary tuberculosis among prisoners in North Gondar Zone Prison, northwest Ethiopia. *BMC infectious diseases*. 2012;12(1):352.
26. Jittimanee S, Ngamtrairai N, White M, Jittimanee S. A prevalence survey for smear-positive tuberculosis in Thailand prisons. *The International Journal of Tuberculosis and Lung Disease*. 2007;11(5):556-61
27. Banu S, Hossain A, Uddin MKM, Uddin MR, Ahmed T, Khatun R, et al. Pulmonary tuberculosis and drug resistance in Dhaka central jail, the largest prison in Bangladesh. *PloS one*. 2010;5(5).
28. Ruddy M, Balabanova Y, Graham C, Fedorin I, Malomanova N, Elisarova E, et al. Rates of drug resistance and risk factor analysis in civilian and prison patients with tuberculosis in Samara Region, Russia. *Thorax*. 2005; 60(2):130-5.
29. Ulmasova D, Uzakova G, Tillyashayhov M, Turaev L, van Gemert W, Hoffmann H. Multidrug-resistant tuberculosis in Uzbekistan: Results of a nationwide survey, 2010 - 2011. 2013; 18:42.
30. Noeske J, Kuaban C, Amougou G, Piubello A, Pouillot R. Pulmonary tuberculosis in the Central Prison of Douala, Cameroon. *East Afr Med J*. 2006 ; 83(1):25-30
31. Owokuhaisa J, Thokerunga E, Bazira J. Prevalence of Pulmonary Tuberculosis among Prison Inmates at Mbarara Central Prison, South Western Uganda.*Advances in Research science domain international*. 2014; 2(11): 618-625.

32. Centers for Disease Control and Prevention (CDC). Rapid assessment of tuberculosis in a large prison system--Botswana, 2002. *MMWR Morb Mortal Wkly Rep*. 2003; 52(12):250-2.
33. Maggard KR, Hatwiinda S, Harris JB, Phiri W, Krüüner A, Kaunda K, et al. Screening for tuberculosis and testing for human immunodeficiency virus in Zambian prisons. *Bulletin of the World Health Organization*. 2015; 93(2):93-101.
34. Cain KP, McCarthy KD, Heilig CM, Monkongdee P, Tasaneeyapan T, Kanara N. An algorithm for tuberculosis screening and diagnosis in people with HIV. *New England Journal of Medicine*. 2010;362(8):707-16.
35. Hussain H, Akhtar S, Nanan D. Prevalence of and risk factors associated with *Mycobacterium tuberculosis* infection in prisoners, North West Frontier Province, Pakistan. *International journal of epidemiology*. 2003;32(5):794-9.
36. Manzoor S, Tahir Z, Anjum A. Prevalence of HIV and tuberculosis among Jail inmates in lahore-Pakistan. *Biomedica*. 2009; 25(7).
37. Rutta, E., Mutasingwa, D., Ngallaba, S., Mwansasu, A. Tuberculosis in a prison population in Mwanza, Tanzania (1994 – 1997). *International Journal of tuberculosis and Lung disease* . 2001;5(8): 703 – 706.
38. Koffi N, Ngom A, Aka-Danguy E, Seka A, Akoto A, Fadiga D. Smear positive pulmonary tuberculosis in a prison setting: experience in the penal camp of Bouake, Ivory Coast. *The International Journal of Tuberculosis and Lung Disease*. 1997; 1(3):250-3.
39. Ministry of Health of Ethiopia Guide lines for clinical and programmatic management of TB, Leprosy and TB/HIV in Ethiopia 5th ed. Addis Ababa, Ethiopia. *MOH*. 2012.
40. Vandepitte J, Verhaegen J, Engbaek K, Rohner P, Piot P, Heuck C. Basic laboratory procedures in clinical bacteriology: World Health Organization.2003.
41. World Health Organization. Physical status: The use of and interpretation of anthropometry. Expert Committee Report. Geneva*: WHO Technical Report*.1995:854. 1-460.
42. Butler T, Levy M. Mantoux positivity among prison inmates--New South Wales, 1996. *Australian and New Zealand journal of public health*. 1999;23(2):185.

43. World Health Organization: World Health Organization Report 2009 Global Tuberculosis Control. Surveillance, Planning, Financing: WHO/HTM/TB;2009:411
44. Amhara National Regional State Health Bureau: Fifth National TB Research Conference. Bahir Dar: *ANRS/TBLCP*; 2009:1–37.
45. Hsueh P-R, Liu Y-C, So J, Liu C-Y, Yang P-C, Luh K-T. Mycobacterium tuberculosis in Taiwan. *Journal of Infection*. 2006; 52 (2):77-85.
46. Maurya V, Vijayan V, Shah A. Smoking and tuberculosis: an association overlooked. *The International journal of tuberculosis and Lung Disease*. 2002; 6 (11):942-51.
47. Yu G-p, Hsieht C-c, Peng J. Risk factors associated with the prevalence of pulmonary tuberculosis among sanitary workers in Shanghai. *Tubercle*. 1988; 69(2):105-12.
48. Upham J, Strickland D, Bilyk N, Robinson B, Holt P. Alveolar macrophages from humans and rodents selectively inhibit T-cell proliferation but permit T-cell activation and cytokine secretion. *Immunology*. 1995;84 (1):14
49. Aoshiba K, Tamaoki J, Nagai A. Acute cigarette smoke exposure induces apoptosis of alveolar macrophages. *American Journal of Physiology-Lung Cellular and Molecular Physiology*. 2001; 281 (6):1392-401.
50. Zachariah R, Spielmann M, Harries A, Salaniponi F. Moderate to severe malnutrition in patients with tuberculosis is a risk factor associated with early death. *Transactions of the Royal Society of Tropical Medicine and Hygiene*. 2002; 96 (3):291-4.
51. Ferreira-e-Silva WT, Galvão BA, Ferraz-Pereira KN, de-Castro CB, Manhães-de-Castro R. Perinatal malnutrition programs sustained alterations in nitric oxide released by activated macrophages in response to fluoxetine in adult rats. *Neuroimmunomodulation.* 2009; 16 (4):219-27.
52. Bhaskaram P. Nitrite production by lymphokine activated peripheral blood monocytes in malnourished patients with tuberculosis. Journal of Nutritional Immunology. 1995; 3 (3):71-81
53. Martin V, Cayla J, Bolea A, Castilla J. Mycobacterium tuberculosis and human immunodeficiency virus co-infection in intravenous drug users on admission to prison. *The International Journal of Tuberculosis and Lung Disease*. 2000; 4(1):41-6.

54. World Health, Organization. WHO policy on collaborative TB/HIV activities. Guidelines for national programmes and other stakeholders. WHO/HTM/TB/2012.1. WHO, Geneva , Swetzerland

ANNEXES

ANNEX I: Questionnaire for the prevalence pulmonary tuberculosis in prison settings

A. Socio demographic information

1. Unique Inmate number/ code no._____
2. Age_____
3. Sex_____
4. Residence before incarceration : Urban □ Rural □
5. Educational status Illiterate □ Read and write □
   Elementary □ High school □
   College and above □
6. Occupation before imprisonment: civil servant (gov't) □ Farmer □
   Self employed □ Merchant □
   Student □ House wife □
7. Marital status before incarceration: Single □ married □ divorced □ widowed □

B. Clinical risk factors

8. Smoking Yes □ No □
9. Previous contact with individual with active TB: Yes □ No □
10. Length of stay in the prisons (in months): <2 □ 2-6 □ 7-12 □ >12 □
11. Do you detain in the prison? Yes □ No □
12. If yes, for how many is frequency of imprisonment: once □ twice or more □
13. Number of prisoners per cell: <50 □ 51-100 □ >100 □
14. Duration of Cough (in weeks): ≥ 2 □ 3 □ 4 □ ≥8 □
15. Sharing food and drink materials: Yes □ No □

16. Window opening practice of inmates never: □ sometimes □ always □

17. Time of occurrence of the cough: Before imprisonment □

After imprisonment □

18. Nutritional status: Under nutrition (BMI < 18.5kg/m2) □

Normal nutrition (BMI >18.5kg/m2) □

19. History of previous treatment: Yes □ No □

20. HIV status of the inmates: Positive □ Negative □

ጎንደር ዩኒቨርስቲ

የ ህክምናና ጤና ሣይንስ ኮሌጅ

የባዮሜድካል እና ላቦራቶሪ ሣይንስ ትምህርት ቤት

በሰሜን ጎንደር ዞን የሚገኙ ማረሚያ ቤቶች የቲቢ በሽታ ይኖርባቸዋል ተብሎ ለተገመቱ ታራሚዎች ለበሽታው ሊያጋልጡ ስለሚችሉ ተያያዥ ጉዳዮችንና ማህበራዊ ኢኮኖሚየዊ ጉዳዮችን ለማወቅ የተዘጋጀ መጠይቅ

ሀ. ማህበራዊ ጉዳዮች

1.የታራሚዉ ሚስጥራዊ ቁጥር…….

2.እድሜ----------

3.ፆታ፡ ወንድ፡ □ ሴት □

4.መኖርያ ከተማ፡ □ ገጠር □

5.የትምህርት ሁኔታ፡ ያልተማረ □ የሚያነብና የሚጽፍ □

1ኛ ደረጃ ት/ቤት □ 2ኛደረጃ ት/ቤት□ ኮሌጅና ከዛ በልይ □

6.የሥራ ዓይነት፡ የመንግስት □ ተማሪ □ ገበሬ □

ነጋዴ □ የቀን ሰራተኛ □ የቤት ሰራተኛ □

7.የጋብቻ ሁኔታ፡ ያላገባ □ ያገባ □ የፈታ □ የፈታ □

ለ. የጤናና ሌሎች ተያያዥ ጉዳዮች

8. ሲጋራ ያጨሳሉ? አዎ □ አይደለም □

9. ከዚህ በፊት ቲቢ ከያዘው ሰው ጋር ግኙኝነት ነበርዎ? አዎ □ አይደለም □

10.በ ማ ረ ምያ ቤት ለ ስ ን ት ግ ዜ ቆ ዩ (በወር)? <2 □ 2-6 □ 7-12 □ >12 □

11. ከ ዚ ህ በ ፊ ት በ ማ ረ ምያ ቤት ገ ብተ ው ያ ውቃሉ? አ ዎ □ አ ላ ወቅ ም □

12. መልስዎ አዎ ከሆነ ለስንት ግዜ? አንድ ግዜ □ ሁለት ግዜ እና ከዛ በላይ □

13. በአንድ የማረምያቤትክፍል የሚኖሩ የታራሚዎች ብዛት፡ <50 □ 51-100 □ >101 □

14. ሳሉ ከጀመረህ ስንት ግዜ ይሆነዋል(በሳምንት)? > 2 □ 3 □ 4 □ >8 □

15. አብሮ መብላትና መጠጣትባህል ፡ አዎ □ አይደለም □

16.መስኮት የመክፈት ባህል ፡ አንከፍትም □ አልፎ አልፎ □ ሁልግዜ □

17.ሳሉ የከመረቦዎት መቼ ነው? ማረምያቤት ከመምጣቴ በፊት □ ማረምያቤት ከመጣሁ ብኋላ □

18.የጠየና ሁኔታ በክንደት(ኪ.ም/ሜ^2)፡ የሜና እክል አለበት(BMI < 18.5 ኪ.ም/ሜ^2) □

ሜናማ (BMI >ኪ.ም/ሜ^2) □

19.ከዚህ በፊት የቲቢ መድሀኒት ወስደው ያውቃሉ? አ ዎ □ አ ላ ውቅ ም □

20.የ ኤች አ ይ ቪ ሁኔታ፡ ፖዘቲቭ □ ነጋቲቭ □

Annex II. Laboratory procedure LED florescent microscope

A. Smear preparation:

Smears should be prepared in manageable batches, suggestively not more than 12 smears per batch. Make sure all smear-samples are labeled with a name or number. Prepare smears from processed specimens such as liquid suspensions obtained from ground or homogenized tissue, sputum, or decontaminated inoculate, in a Bio safety cabinet type I.

1. Label new, clean, unscratched microscope slide at one end with the relevant sample name/number. Avoid touching the surface of the slide.

2. Thoroughly mix the specimen with a pipette (1ml) and place about one drop (or 2 – 3 loopfuls) on the slide.

3. Using stick applicator spread the smear over a surface of about 2cm x 3cm.

4. Allow the smear to air dry completely in the BSC I. Do not use heat for drying!

5. Heat-fix the slide either by passing it through a flame three to four times with the smear side up. Alternatively, allow the slide to fix on an electric slide warmer at 65 - 75ºC for 2-3 hours or overnight. Do not overheat or expose smears to UV light (6). Let the slide cool before staining.

B. Staining procedures for LED fluorescence microscope

1. Label a new clean, unscratched slide at one end with the laboratory number using diamond tipped stylus
2. Use muco-purulent portion for smear preparation. Transfer an appropriate portion of the specimen to the slide by using a broom-stick or nichrome wire loop of 5mm dm (27 SWG).
3. Smear the specimen over an area of approximately 2 by 3 cm. Make it thin enough to be able to read through it. Use a fresh slide for each specimen
4. Allow smears to air-dry for 15 minutes. Do not use heat for drying

5. Fix the smear to the slide by passing it over the flame 3 to 5 times for 3 to 4seconds each.
6. After making smear, burn and dispose the broom-stick or flame wire loop thoroughly using side burner prior to re-use.
7. Place the slides on a staining rack, with the smeared side facing up, the slides not touching each other
8. Flood the slides with freshly filtered auramine-phenol. Let stand for 7-10
Minutes

9. Wash well with running water, taking care to control the flow of water so as to prevent washing away the smear
10. Decolorize by covering completely with acid-alcohol for 2 minutes, twice

11. Wash well with running water, as before to wash away the acid alcohol
12. Counter stain with 0.1% potassium permanganate for 30 seconds

13. Wash as before with water and slope the slides to air dry

14. Switch on the mercury vapor lamp. The bulb takes approximately 10 minutes to reach full intensity. Using the low power objective (magnification 100-150x) first examine a known positive slide to ensure that the microscope is correctly set up.

15. With auramine staining, the bacilli appear as slender bright yellow fluorescent rods, standing out clearly against a dark background.

Auramine O fluorescent staining grading (using 20 or 25x objective and10x eye piece)	**Reporting /Grading**
>100 AFB/field after	examination of 20 fields
11-100 AFB/field after	examination of 50 fields
1-10 AFB/ field after	examination of 100 fields
1-3 AFB/100 fields	doubtful positive /repeat
No AFB per 100 fields	Negative

ANNEX III .Laboratory procedure for Xpert MTB/RIF
Sample Procedure

1. Mix "Sample reagent buffer SRB " with the sample (Add 2:1 sample reagent buffer to sample ratio)

    A. Shake then stand 10 minutes
    B. Shake then stand further 5 minutes.

    Note: After 15 min incubation, if the mixture remains viscous, shake the sample again and leave it for additional 5 min until it gets liquefied.
2. After 15 minutes incubation at room temperature:

    A. Remove Xpert cartridge from its wrapper. Take care not to touch the back of the cartridge
    B. Label the side of the Xpert cartridge with the sample ID. Do not write or place sticker over cartridge barcode.
    C. Open the lid of the cartridge.
    D. Open the lid of the collection container containing the mixed sputum specimen.

E. Open a sealed sterile pipette (supplied in kit) without touching the tip. Use the pipette to aspirate >2ml of the specimen (just above 2ml mark on pipette) **Note**: Do not add less than 2ml of mixed specimen to the cartridge.

F. Slowly transfer/dispense 2ml SRB and sample mixture into the open port of the Xpert MTB/RIF cartridge (loading in to the Xpert MTB/RIF cartridge)

G. Close the cartridge lid firmly.

H. Dispose of the specimen collection container, pipette and leftover SR buffer into a suitable medical waste bin.

I. Take the Xpert cartridge to the bench with the GeneXpert instrument.

J. Show the proper disposal of leftover SR buffer, used transfer pipettes, and etc

K. Remove your gloves and hand wash and change a new glove before you are going to load to GeneXpert instrument

L. Insert the cartridge and start the test. Test should be launched within 30 minutes.

3. Running the test

4. Interpreting test results

- After completion of the run, click on the '**View Results'** icon on the system toolbar.
- Click on '**View Test**' at bottom of the result screen toolbar.
- Select the patient test by clicking on the patient ID field. This will highlight the test.
- Click '**OK**' and the result screen will be displayed as one of the following:
  - MTB DETECTED – positive (with/out RIF resistance)
  - MTB NOT DETECTED - negative
  - INVALID – repeat test
  - ERROR – repeat test
  - NO RESULT – repeat test

5. Reporting

- MTB detected
- MTB not detected
- RIF Resistance detected
- RIF resistance not detected
- RIF resistance indeterminate

ANNEX IV: Consent form

Dear Madam/sir

My name is Teklay Gebrecherkos and I am from the School of Biomedical and Laboratory Sciences, University of Gondar. I am gonging undertake a research entitled "**Prevalence and MDR PTB in prison settings of North Gondar zone, Northwest Ethiopia**". I am going to assess the prevalence of smear positive TB and multi drug resistance due to different associated factors in three prisons of north Gondar. So this study will help us to determine the magnitude of the problem that will be farther contribute to create awareness and plan new strategy for policy makers and responsible bodies. The information from this study will not be used for other purposes by any of the institutions and individuals without your agreement and the information will be completely confidential. If you do have any questions or problems at any time, you can contact me by mobile: 0922795314 or by Email: tgchirkos@yahoo.com

Your sincerely

Teklay Gebrecherkos

On behalf of ----------Prison inmate, I the undersigned have understood the objective of the study in titled with "**Prevalence pulmonary tuberculosis in prison settings of North Gondar zone, Northwest Ethiopia**" and I agreed what is explained by the investigator. I also allowed to him to give all the required information and enough amount of Sputum samples for laboratory analysis and other information.

Name…….Signature…….. ……Date …….

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DECLARATION

The research work in this thesis proposal entitled “Prevalence of pulmonary tuberculosis in prison settings of North Gondar zone, Northwest Ethiopia” was carried out by me under the

supervision of Dr. Belay Tessema and Dr. Baye Gelaw in the College of Medicine and Health Sciences, School of Biomedical and Laboratory Sciences, Department of Medical Microbiology for the award of MSc degree in Medical Microbiology. I declare that this work is original and the thesis has not been previously submitted in part or full for any degree or diploma of this or any other University.

Advisors

Name	Signature
1. Dr.Belay Tessema	_____
2. Dr. Baye Gelaw	_____

Examiners

Name	Signature
1.	_____
2.	_____